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It is easily seen that when the same proportion of alcohol to water prevails, the contents of the alcohol in the first vessel will be  $=a^2/(a+b)$ .

$\therefore x$  must be  $=\infty$ .

II. Solution by G. B. M. ZERR, A. M., Ph. D., Parsons, W. Va.

After the first operation, there are  $a-c$  gallons of alcohol in the first vessel, and  $c$  gallons of alcohol in the second vessel. After the second operation, there are  $a-2c+c^2(1/a+1/b)$  gallons of alcohol in the first vessel, and  $2c-c^2(1/a+1/b)$  gallons of alcohol in the second vessel.

Let  $A=c(1/a+1/b)$ . Then, after the third operation, there are  $a-3c+3Ac-A^2c$  gallons of alcohol in the first vessel, and  $3c-3Ac+A^2c$  gallons of alcohol in the second vessel. After the  $n$ th operation there are

$a-nc+\frac{n(n-1)}{2!}Ac-\frac{n(n-1)(n-2)}{3!}A^2c+\dots\pm A^{n-1}c=a+\frac{c(1-A)^n-c}{A}$  gallons of

alcohol, and  $\frac{c-c(1-A)^n}{A}$  gallons of water in the first vessel, and

$nc-\frac{n(n-1)}{2!}Ac+\frac{n(n-1)(n-2)}{3!}A^2c-\dots\pm A^{n-1}c=\frac{c-c(1-A)^n}{A}$  gallons of alco-

hol, and  $b+\frac{c(1-A)^n-c}{A}$  gallons of water in the second vessel.

$$\therefore \frac{Aa+c(1-A)^n-c}{c-c(1-A)^n} = \frac{c-c(1-A)^n}{Ab+c(1-A)^n-c}.$$

$$\therefore (1-A)^n = \frac{c(a+b)-Aab}{c(a-b)} = 0. \quad \therefore n = -\infty, \text{ or } A=1.$$

$\therefore$  The result stated can only happen when  $a=b=2c$ , then  $n=1$ .

156. Proposed by R. D. CARMICHAEL, Hartselle, Ala.

There exist no multiply perfect odd numbers of multiplicity  $n$  containing only  $n$  distinct primes.

Solution by JACOB WESTLUND, Ph. D., Purdue University, Lafayette, Ind.

If  $n$  denotes the multiplicity of a multiply perfect number  $p_1^{a_1} p_2^{a_2} \dots p_i^{a_i}$ , where  $p_1, p_2, \dots$  are distinct primes, we have

$$n = \frac{p_1 - \frac{1}{p_1^{a_1}}}{p_1 - 1} \cdot \frac{p_2 - \frac{1}{p_2^{a_2}}}{p_2 - 1} \dots, \text{ and hence } n < \frac{p_1}{p_1 - 1} \cdot \frac{p_2}{p_2 - 1} \dots \frac{p_i}{p_i - 1}.$$

Now, if  $p_1 > 2$ , we have

$$\frac{p_1}{p_1-1} \cdot \frac{p_2}{p_2-1} \cdots \frac{p_i}{p_i-1} \leq \frac{3}{2} \cdot \frac{4}{3} \cdots \frac{i+2}{i} = \frac{i+2}{2}.$$

Hence we should have  $n < \frac{i+2}{2}$ , or  $i > 2n-1$ .

## PROBLEMS FOR SOLUTION.

### ALGEBRA.

256. Proposed by THEODORE L. DeLAND, Treasury Department, Washington, D. C.

Three men, A, B, and C, rented a pasture for a fixed amount, each to pay per month in proportion to the stock pastured. During the first month A put in 3 horses and B and C each some horses, and B paid for the month \$6, but A and C each defaulted payment. During the next month each put in one more horse, and C paid for the month \$7.20, but A and B each defaulted payment. During the next month each put in one more horse, and A paid his bill for the month, \$5, but B and C each defaulted.

Required: (1) the rent of the pasture per month; (2) the number of horses B and C each put in during the first month; and (3) the amount A, B, and C, each, owed for the unpaid service.

257. Proposed by L. E. NEWCOMB, Los Gatos, Cal.

Solve (1)  $x+y=10$ , (2)  $3x=\log_{10} y$ .

258. Proposed by R. D. CARMICHAEL, Hartselle, Ala.

Sum the infinite series  $\frac{n^2}{(4n^2-1)^2}$  beginning with  $n=1$ ,  $n$  being always odd.

### CALCULUS.

216. Proposed by R. D. CARMICHAEL, Hartselle, Ala.

Find the limit of the sum of the series

$$\frac{n}{n^2+1^2} + \frac{n}{n^2+2^2} + \frac{n}{n^2+3^2} + \cdots + \frac{n}{n^2+m^2},$$

when  $n$  and  $m$  are indefinitely increased. (Distinguish the several cases arising from the different *relative* values of  $m$  and  $n$ .)

217. Proposed by S. A. COREY, Hiteman, Iowa.

In *The Analyst*, Vol. II, p. 120, 1875, G. W. Hill finds by the method of mechanical quadrature the value of  $\int_0^{\frac{1}{2}\pi} \frac{x dx}{\sin x [1 + .16 \cos^2 x]^{\frac{1}{4}}}$  to be 1.6576363.

Evaluate the definite integral by some other method and verify above result.